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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Use of Acetals

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Abstract of the Disclosure:

Use of acetals

Acetals are used as a mineral oil substitute, oil component or base oil in invert-emulsion drilling muds, emulsion drilling muds, engine oils, gearbox oils, lubricating oils and also metal-working fluids, coolants, cooling lubricants and hydraulic fluids. As compared with conventional mineral oils, acetals show good biodegradability and are less toxic.

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Description

Use of acetals

Mineral oils are in many cases the base oils or components for invert-emulsion drilling muds, emulsion drilling muds, engine oils, gearbox oils and lubricating oils and also metal-working fluids, coolants, cooling lubricants and hydraulic fluids. Their biodegradation proceeds relatively slowly and incompletely.

Mineral oil fractions are predominantly or widely used for invert-emulsion drilling muds, emulsion drilling muds, engine oils, gearbox oils and lubricating oils and also metal-working fluids, coolants, cooling lubricants and hydraulic fluids. To satisfy the intended use, they are processed, and suitable additives are added. More recently, increasingly more biodegradable products are demanded for ecological reasons. This is particularly important if some contamination of the environment can never be completely excluded, such as is the case especially in drilling for petroleum and natural gas. Invert-emulsion drilling muds (water-in-oil emulsions) and emulsion drilling muds (oil-in-water emulsions) are used for this purpose. The invert-emulsion drilling muds with the hydrocarbon as the continuous phase are of greater importance. With this mud type, all the solids, the rock drilled off by the bit, the well walls and the drill pipes are wetted with oil owing to the addition of additives. As a result, the well walls are very satisfactorily stabilized and friction during drilling is minimized. The drill cuttings separated off above ground are wetted with oil and require separate disposal. Ecological problems arise offshore if the drilling mud or mud volumes pass into the sea. The drilling mud then sinks to the sea floor, where it renders all living

organisms hydrophobic, i.e. kills them in its area of spread. A particular disadvantage here is the poor biodegradability and toxicity of the oils used. Originally, diesel oil was used. More recently, increasingly more highly purified oils of lower toxicity with less than 0.5% of aromatics are used.

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Compounds such as alcohols (EP-A-0,398,112), esters (EP-A-0,398,113) and ethers (EP-A-0,391,251) have been proposed and tested as more readily biodegradable base oils. With respect to toxicity and biodegradability, these products are a step forward, but the demands to be met by a base oil with respect to pour point, viscosity, saponifiability and odor considerably restrict their use. Surprisingly, it has now been found that, using acetals, the properties of the base oils can be optimized by the selection of the aldehydes and alcohols. This is particularly important for the pour point and the viscosity.

The invention thus relates to the use of acetals in invert-emulsion drilling muds, emulsion drilling muds, motor oils, gearbox oils and lubricating oils and also in metal-working fluids, coolants, cooling lubricants and hydraulic fluids. They wholly or partially replace the hitherto known base oils, oil components and mineral oils here.

As a protective function for aldehydes, acetals are of great importance in preparative organic chemistry. Aldehyde groups are converted into acetals by means of alcohols, various reactions, including reactions under aggressive conditions, are then carried out in the neutral and alkaline range, and the acetal is cleaved again into alcohols and aldehyde in the acidic range.

The acetals according to the invention are synthesized by elimination of water from aldehydes and alcohols in the acidic range. Their known high stability in the alkaline

range makes it possible to optimize the alkalinity in invert-emulsion drilling muds, for example, with calcium hydroxide, which has a particular advantage over ester-based oils. The acetals can be converted by a simple acid treatment into the very easily biodegradable components, if the already high degradability is to be further increased.

Aldehydes having 1 to 25 carbon atoms are particularly suitable for preparing the compounds according to the invention. They can be branched or unbranched, saturated or unsaturated and aliphatic or aromatic. Preferably, C_1- to C_{10}-aldehydes are used. The alcohols used are especially monohydric alcohols having 1 to 25 carbon atoms, preferably 4 to 20 carbon atoms. They can be branched or unbranched, saturated or unsaturated and aliphatic or aromatic. The acetals can be composed of a mixture of different alcohols and/or aldehydes or of pure alcohols and/or aldehydes of the same chain length. The compounds according to the invention can also be prepared on the basis of divalent aldehydes, especially those having 1 to 10 carbon atoms, such as glyoxal, tartaric acid dialdehyde, succindialdehyde, maleic acid dialdehyde and fumaric acid dialdehyde, but preferably glyoxal, with said alcohols.

Because further additives, which improve the lubricating and other properties, are highly soluble in the acetals, the acetals are very suitable as base oils, oil components, mineral oil substitute or mixing components for invert-emulsion drilling muds, emulsion drilling muds, engine oils, gearbox oils and lubricating oils and also metal-working fluids, coolants, cooling lubricants and hydraulic fluids. A particular advantage of the acetals is that they are partially miscible with mineral oil fractions and polyglycol ethers, so that the acetals can also be used together with these compounds.

As a component in the invert-emulsion drilling muds, emulsion drilling muds, engine oils, gearbox oils and lubricating oils and also metal-working fluids, coolants, cooling lubricants and hydraulic fluids, the acetals are usually present in a quantity of at least 0.5% by weight. In the case of partial to complete substitution for the existing base oils or the oily phase, they form up to 100% by weight of these fluids, with the exception of the emulsion drilling muds, in which their content is at most 50% by weight (the remainder being water).

The invention is explained in more detail by reference to the examples which follow.

General instructions for the preparation of the acetals used in the following Examples I to IX:

3.5 mol of aldehyde, 14 mol of alcohol and 500 g of n-hexane, methylene chloride or chloroform are mixed, 1 g of p-toluenesulfonic acid is added as catalyst and the mixture is heated to the boil. The water formed is distilled off azeotropically. After the formation of water has ended, the mixture is rendered alkaline with Na methylate solution, and the entrainer and the unreacted alcohol are then distilled off. The precipitated salt is then filtered off from the acetal which can be distilled if desired.

Physical data:

Examples I to IX

Description		Melting point	Boiling point	n_D^{21}	Viscosity mPas, 15°C
I	Acetaldehyde di-n-hexylacetal	<-60°C	246°C	1.4235	2.76
II	Acetaldehyde di-2-ethylhexyl-acetal	<-60°C	269°C	1.4350	5.19
III	Butyraldehyde di-n-butylacetal	<-60°C	196°C	1.4160	1.9
IV	Isobutyraldehyde di-n-hexylacetal	<-60°C	251°C	1.4270	3.8
V	Isobutyraldehyde di-n-octylacetal	<-40°C	230°C	1.4351	7.7
VI	n-Butyraldehyde di-n-octylacetal	<-60°C	224°C	1.4370	7.6
VII	Isononylaldehyde bis-$C_{12/14}$-acetal	-15°C	239°C	1.4488	40.6
VIII	Isononylaldehyde bis-C_{16}-acetal	-42°C	300°C	1.4536	183 (20°C)
IX	Glyoxal tetrabutyl-diacetal	<-70°C	278°C	1.4260	6.7

The values given in the list for melting point (pour point) and viscosity of the acetals demonstrate the wide applicability according to the invention of these compounds.

Laboratory testing of acetals as substitutes for mineral oils in invert-emulsion drilling muds

Mud formulation:

245 ml of acetal according to the invention are placed into a Hamilton Beach (HB) mixer. The HB mixer is switched on in the "high-speed" position. In portions, 8 g of ®Tixogel (bentonite rendered hydrophobic, from Südchemie), 9 g of anionic emulsifier (70%, dodecylbenzenesulfonate), 3 g of cationic emulsifier (85%, imidazoline type) and 10 g of CaO are added. The mixture is stirred for 5 minutes. 105 ml of $CaCl_2$ solution (20%) are then added in portions.

After a further 10 minutes stirring time, 275 g of barium sulfate are introduced, which raises the density of the mud to 1.46 g/cm³. The complete mud is stirred again for 20 minutes. This is followed by measurements of the rheology (at 50°C) and of the water loss (25°C) of the mud. After ageing for 18 hours at 65.5°C, the measurements are repeated. Before and after the ageing, the electrical stability (ES) is measured in volt, using the Fann model 23D.

Acetals according to Examples I-VI as a base for the invert-emulsion muds 1 to 6

D = comparison sample based on diesel oil
WL = water loss
SV = apparent viscosity (mPa s)
PV = plastic viscosity (mPa s)
FL = flow limit (lb/100 sq ft)
10" gel = (lb/100 sq ft)
10' gel = (lb/100 sq ft)

The values for SV, PV, FL, 10" gel and 10' gel were determined according to API Recommended Practice, Standard Procedure of Field Testing Water-Based and Drilling Fluids 13 B-1 (RP 13 B-1), Section 2, and the values for WL were determined according to the same

standard, Section 3.

Test results: Invert-emulsion muds 1 to.6
Before ageing

	1	2	3	4	5	6	D
ES (V)	440	543	432	482	501	702	600
WL cm^3	1.4	0.6	1.8	1.1	0.7	0.6	0.9
SV	18	27	15	22	43	36	28.5
PV	16	24	13.5	21	32	29	16
FL	4	6	3	2	22	14	25
10" gel	0.5	2.5	1	1	5	5	3
10' gel	0.5	2.5	1	1	5	5	3

After ageing

	1	2	3	4	5	6	D
ES (V)	456	634	500	600	530	794	750
WL cm^3	1.4	0.9	2.3	1.2	0.6	1.0	1.1
SV	20.5	31.5	18.5	27.5	50	42	33
PV	16	26	15	23	36	31	25
FL	9	11	7	9	28	22	16
10" gel	2	4.5	2.5	3.5	14	10	6.5
10' gel	2	4.5	2.5	3.5	14	10	6.5

By comparison with the sample based on diesel oil, the test results show that the compounds according to the invention are substitutes for mineral oils. By means of different combinations of aldehydes and alcohols in the acetals, these products have a very wide flexibility as a mineral oil substitute in their application. For the various fields of application, the required properties, especially the pour pointand viscosity, can be adjusted within a very wide interval.

An invert-emulsion mud of low density, for example below 1.20 g/cm³, can contain acetals having relatively long alkyl radicals for adjusting the hydrocarbon phase to a higher viscosity. If, however, it is necessary to drill at high densities, for example above 2.0 g/cm³, acetals having lower alkyl radicals are advisable. In this way, it is possible to adjust the hydrocarbon phase to viscosities which are below those of the normally usable mineral oils and virtually equate to that of water. Invert-emulsion muds based on low-viscosity acetals have a lower viscosity and a lower viscosity difference between above ground (about 20°C) and the bottom of the well at great depths (for example 150°C) than those based on mineral oil. It is possible in practice to formulate invert-emulsion muds optimized for defined depths and formations.

Testing the lubricating action of acetals as a mineral oil substitute in invert-emulsion muds

The test is carried out using the "Extreme Pressure (EP) Lubricity Tester" part No. 212-1 from NL Baroid, NL Industries, Inc. With this, the relative lubricating power of mud fluids under extreme pressure is measured. At the same torque, the times in various lubricant media are measured at which a testing ring rotating against a testing block seizes. The comparison fluids used are the invert-emulsion muds 1 to 6 and D and also a water-based drilling mud with 4% of bentonite, whose weight was raised with baryte to a density of 1.46 g/cm³. The water-based drilling mud contains no added hydrocarbon.

Results of the lubrication test:

I With the water-based drilling mud, seizing occurred at 300 inch/lbs after about 30 seconds.

II The muds 1 to 6 and D showed comparably good lubricating effects, and there was still no seizing after 5 minutes at 300 inch/lbs.

Invert-emulsion muds based on the acetals according to the invention differ significantly in their lubricating action from water-based drilling muds. They are comparable with invert-emulsion muds based on diesel oil. In this respect too, the acetals are good substitutes for mineral oil fractions such as diesel oil.

Comparative testing of the specific surface pressure of acetals and other oils.

The test is carried out using the Reichardt frictional wear balance (from Sommer und Runge, Berlin). In this test method, the specific surface pressure is measured.

The specific surface pressure of diesel oil, ®Shell-Gravex 915 (mixed-base typical oil from Shell, about 50% paraffin-based and about 50% naphthene-based), isobutyraldehyde di-2-ethylhexylacetal and acetaldehyde di-n-octylacetal is listed in the following Table.

Test results:

Lubricant	Specific surface pressure (bar)	%
Diesel oil	68.2	100
®Shell-Gravex 915	76.0	111.4
Isobutyraldehyde di-2-ethylhexylacetal	83.0	122.1
Acetaldehyde di-n-octylacetal	110	161

The higher the specific surface pressure at which lubrication collapses, the better is the lubricating action of the fluid. The results show that the acetals according to the invention are very suitable as the base or as a component of a lubricant formulation.

Testing the biodegradability:

The biodegradability is tested by the modified Sturm test OECD 301 B, total degradation via CO_2 measurement. The percentage data relates to the theoretically possible quantity of CO_2. The CO_2 was measured over a period of 28 days.

Substance	10 mg/l	20 mg/l	Results
Isobutyraldehyde di-2-ethylhexylacetal	71%	63%	biodegradable
Acetaldehyde di-n-octylacetal	75%	66%	biodegradable

The testing of the biodegradability of isobutyraldehyde dibutylacetal is carried out according to the modified OECD Screening Test 301 E 12.

At 95% on average (relative to active compound), the test substance reaches1Xaverage threshold value of 70% DOC reduction (total degradation to CO_2 and H_2O minimization).

The acetals according to the invention are distinguished by easy biodegradability and have a less toxic action on microorganisms.

Patent Claims:

1. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid, which contains acetals.

2. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid as claimed in claim 1, which contains acetals based on monovalent aldehydes having 1 to 25 and especially 1 to 10 carbon atoms and on monohydric alcohols having 1 to 25 and especially 4 to 20 carbon atoms.

3. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid as claimed in claim 2, which contains acetals in which the hydrocarbon radicals of the aldehydes and alcohols are linear or branched, saturated or unsaturated and aliphatic or aromatic.

4. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid as claimed in claim 1, which contains acetals based on dialdehydes and monohydric alcohols.

5. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid as claimed in claim 4, which contains acetals in which the dialdehyde components have 1 to 10 carbon atoms and the alcohol components have 1 to 25 and preferably 4 to 20 carbon atoms.

6. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid as claimed in claim 4 or 5, which contains acetals in which the hydrocarbon radicals of the alcohol components are linear or branched, saturated or unsaturated and aliphatic or aromatic.

7. An invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid as claimed in any of claims 1 to 6, wherein the invert-emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid contains 0.5 to 100% by weight of acetals and the emulsion drilling mud contains 0.5 to 50% by weight of acetals.

8. The use of acetals in an invert-emulsion drilling mud, emulsion drilling mud, engine oil, gearbox oil, lubricating oil or metal-working fluid, coolant, cooling lubricant or hydraulic fluid.

9. The use of acetals based on monovalent aldehydes having 1 to 25 and especially 1 to 10 carbon atoms and monohydric alcohols having 1 to 25 and especially 4 to 20 carbon atoms, as claimed in claim 8.

10. The use of acetals as claimed in claim 9, in which the hydrocarbon radical of the aldehydes and alcohols are linear or branched, saturated or unsaturated and aliphatic or aromatic.

11. The use of acetals based on dialdehydes and monohydric alcohols, as claimed in claim 8.